

- Culverts are 2 to 3 feet in diameter and channel is 2 to 6 feet wide.
 - Need only bankfull width and reasonable estimate of stream bottom slope and burying depth.
- Culverts are 3 to 6 feet in diameter and channel is up to 12 feet wide.
 - Need bankfull width, and accurate longitudinal profile of the stream to have exact slope of the stream and culvert elevation at both the inlet and outlet. Will require the use of level survey equipment.
- Culverts are greater than 6 feet in diameter or wide arch design and channel is greater than 12 feet wide.
 - Need bankfull width, longitudinal profile, and 1-3 cross sections. Use computerized culvert design programs to confirm that all measurements accurately dictate culvert design and installation parameters. Generally applied when stream crossing design requires the involvement of a registered professional civil engineer.

9. RUTTING AND RELATED ISSUES

Rutting occurs when soil strength is not sufficient to support the applied load from vehicle traffic (see Figure 19; Table 2 on page 17 has more on soil susceptibility to erosion). Rutting affects aesthetics, biology, hydrology, site productivity and vehicle safety. In general, rutting can cause soil compaction and loss of forest productivity. Where channelized flow to an open water body occurs, rutting can result in contributing sediment into an open water body. While not always a water quality issue, excessive rutting is certainly a sign that ongoing forest operations need to be modified to prevent further damage to soil and forest resources.



Figure 19. Forest Road Rutting Damage

Table 6 (below) provides guidance on excessive rutting in different areas of a harvest operation, immediate actions to be taken and restoration requirements. The rutting guidance should be applied in relation to the specific area being harvested. Consideration should be given to soils, hydrology, forest type, slope, and other site factors. For example, on certain sites, it may be necessary to change or halt operations before the standards stated are exceeded. Conversely, deep ruts may not be a problem in a landing which will be smoothed and revegetated after a harvest. In addition, excessive rutting in wetlands may require a DEQ permit. To avoid the need for a permit, methods should be employed to avoid and minimize rutting in wetland areas.

Anytime rutting causes sedimentation in a stream, lake or open water wetland, the activity causing the rutting must stop and immediate actions taken to prevent further sediment deposition. Rutting in roads or landings that does not cause sedimentation should be monitored. If ruts begin to exceed the specifications, measures should be taken to prevent further rutting. If further rutting cannot be prevented, the operations should cease until conditions change or until the rutting can be repaired. Off road rutting in the woods may occur

on skid trails. Heavily used trails, also called main skid trails, may have more rutting than “one time only” trails or secondary trails. Consideration should be given to the overall impact of the skid trails across the landscape.

It would be difficult to define guidance related to the total length and depth of skid trails across a forested stand, but in general the amount of skid trails should be minimized. Major skid trails will have more rutting than secondary skid trails. If secondary skid trails begin to resemble major skid trails, then rutting may be too severe, even though the rutting guidance has been followed. Excessive rutting may occur even though any individual length of skid trail is within the standards. Professional judgment should be used to identify excessive rutting across a forested stand.

Surface water runoff from rain events can also lead to ruts in a logging road. The ruts collect runoff and increase the potential for ruts to deepen and further road erosion. Roads having slopes greater than 5% are especially vulnerable to the creation and deepening of ruts from rain events. Installing the proper water diversion devices, such as diversion ditches or broad-based dips at the appropriate intervals will periodically interrupt and divert stormwater runoff and decrease the volume and velocity of storm water runoff as it moves down slope. This reduces the potential for rutting. Proper grading, crowning of roads and shaping of roads per soil and slope conditions (see Figure 4) can also reduce the potential for rutting. Heavily sloped roads (those with slopes greater than 10%) can become rutted very easily, so the driver/operator must use extra care when driving these roads with heavy loads or under wet conditions.

Finally, the land manager must make sure that all man-made/inorganic materials (e.g. silt fence, tire mats, geotextile fabric) that were used for either rutting, erosion or sedimentation control, are removed from the site shortly after these materials are no longer needed (e.g. grassy vegetation has established). In particular, a silt fence left in place long after its use has past can serve as a barrier to the travel of herptofauna (e.g. turtles, snakes, lizards, salamanders and frogs) and small mammals.

Table 6. Soil Protection Precautions (for rutting)

Immediate Action		
<ul style="list-style-type: none"> If a possible problem arises or threatens to worsen, stop operations. Assess the situation. Can operations be moved to another area to minimize problems without creating additional problems or should operations be stopped until conditions improve? Can precautionary measures eliminate the problem? For example: <ul style="list-style-type: none"> Use slash or logs to prevent movement of sediment offsite. Install rock check dams (using rock 3-12 inches in diameter) or water bars at appropriate intervals (water bars can be made from old conveyor belts or other rubberized material) . Use slash, tire mats, or PVC pipe linked together with chain or cable and lay over areas susceptible to rutting or use other suitable methods to prevent further rutting. Install silt fence at edges of landing or other active areas to prevent movement of sediment off site. In RMZ's, fill in rutted areas, apply geotextile fabric over rutted and susceptible areas, then apply gravel or crushed rock over the fabric at a depth no less than 3 inches (6 inches is optimal). 		
Location	Precautions may be needed if:	Maintenance/Restoration Options
Everywhere	<p>A gully or rut of any depth is channelizing flow to an open water body, (i.e. stream, lake or wetland).</p> <p>Note: the discharge of sediment into a surface water body is in a violation of Part 31, Water Quality Protection, NREPA, PA 451, 1994. Enforcement action and daily fines by DEQ may result if the discharge is not stopped</p>	<p>Review site conditions and determine if site remediation would cause more damage to soil resources and site productivity than leaving ruts as they are.</p> <p>Repair gullies and ruts. Disc, plow, smooth, where necessary. Seed and mulch per recommended procedures (see Appendix E). Check dams and water bars should be left in place until grassy vegetation is firmly established.</p> <p>No restoration is recommended if such action causes more damage to site (e.g. disking and plowing may result in unacceptable damage to the root systems of the trees affected by the rutting).</p> <p>Areas prone to rutting may require frequent inspections.</p>
Roads	<ul style="list-style-type: none"> In a riparian management zone (RMZ) or wetland where a gully or rut is 6 inches deep and 25 feet long. In an upland area (outside of RMZ) where a gully or rut is 12 inches deep and 50 feet long. 	<p>Review site conditions and determine if site remediation would cause more damage to soil resources and site productivity than leaving ruts as they are. Where water quality will not be affected, remediation may not be necessary. The type of road and use (temporary, intermittent, continuous or heavy use), may determine the level of restoration effort.</p> <p>If a rutted road must be used (e.g. for access, to move forest products), options for repair include 1) fill in ruts as conditions allow, 2) lay a barrier such as geotextile fabric over the length of the rutted portions and apply gravel or crushed rock at a depth no less than 3 inches (6 inches is optimal).</p> <p>Smooth, seed and mulch as appropriate, for example after timber harvest is completed (Refer to Appendix E for instructions).</p> <p>Be aware of vehicle safety concerns on forest roads. Rutting may require frequent grading during rainy seasons.</p>
Landings (Should not be located in an RMZ.)	Soil moves from the landing area.	<p>When landing is no longer needed, smooth, seed and mulch as appropriate (Refer to Appendix E for instructions).</p> <p>Silt fence or barriers should be left in place until grassy vegetation is firmly established. Remove silt fence or barriers after its purpose is no longer required.</p>
Skid trails and harvest areas	Where a gully or rut is 12 inches deep and 50 feet long.	<p>No restoration is recommended if such action causes more damage to site (e.g. disking and plowing may result in unacceptable damage to the root systems of the trees affected by the rutting).</p> <p>Remove barriers and materials (tire mats, PVC pipe, etc.) after their use is no longer required and their removal does not create additional problems.</p>

10. LANDINGS

The following BMPs apply to the site location and water management with respect to log landings:

- Locate landings outside the RMZ.
- Use previously developed landings, unless they are located in RMZs.
- Avoid locating or using old landings that are located where gullies, seeps, vernal pools and other permanently wet areas exist.
- Locate sites for log landings in advance of road construction. These sites should be located in areas that will help minimize skid trail and haul road distances.
- Where possible, log landings should be constructed on well-drained, gently sloping sites of no more than 5%. On areas greater than 5%, additional erosion control measures may be necessary.
- Locate residue piles (particularly aspen, whose runoff is a suspected toxin to fish) away from drainages where runoff may wash residue into streams, lakes or other open water body.
- Haul roads that terminate at the landing area should be properly drained prior to intersecting the log landing.
- A diversion ditch around the uphill side of landings can intercept the flow of water and direct it away from the landing.

11. SKIDDING

A skid trail is a single lane trail used for the skidding or transporting of timber products from the stump to a landing. After the location of log landings are established and road layout is complete, the skid trail network is then laid out. The major considerations for skid trail placement are to minimize: damage to residual trees, erosion, sedimentation, and rutting.

For some forest conditions such as very steep slopes (over 40%), unstable soil conditions and critical riparian areas (e.g. areas with vernal pools, unique natural communities, such as dune and swale complexes), use timber harvesting techniques and equipment that minimize skidding throughout the stand (e.g. cable skidding, harvesters with knuckle boom cranes and bogey tracks - see Figure 20).



Figure 20. Wheeled Harvester/Processor with Bogey Tracks.

The Following are Considerations for the Location and Use of Skid Trails:

- Gradients of skid trails should not be steeper than 40% (EPA 2005). The goal is to have the average skid trail slopes be no more than 15%.
- Minimize skidding in the RMZ (this helps minimize soil exposure) .
- When skidding in areas with steep topography, within safe operating conditions, follow the contour of the slope. This reduces soil erosion and encourages revegetation. If skidding has to be done parallel to the slope, skid uphill, taking care to break the grade periodically. Where the grade is broken, install water diversions.
- Avoid skid trail layouts that concentrate runoff into ephemeral draws (see Figure 21), and avoid skidding up or down ephemeral draws. Skidding through these areas will result in accelerated soil erosion and sediment movement, as ephemeral draws act to channelize water flows.
- If using a wheeled skidder without high floatation tires, winch logs out of the RMZ or directionally fell trees so tops extend out of the RMZ and trees can be skidded without operating the skidder in the RMZ.
- Suspend skidding during wet periods such as spring breakup.
- Any skid trail that crosses a stream will require permits from DEQ and a bridge or a culvert designed to standards acceptable by DEQ prior to DEQ issuing permits for such an activity. Logs cannot be skidded through an identifiable stream channel.

- Approaches to a water crossing should be as near to right angles (90 degrees) to the stream direction as possible.
- Climb up slope on a slant or zigzag pattern, breaking the grade and avoiding long steep grades on the trail. This will reduce the potential for making gullies.
- One primary skid trail may concentrate and minimize soil disturbance and compaction and damage to the residual stand. However, often using several different skid trails instead of only one primary trail disperses the impacts and results in less soil disturbance. This may vary by site, time of year, equipment, and other conditions such as existing vegetation.
- Skidding operations should avoid gullies, seeps, vernal pools and other permanently wet areas.
- Upon completion of skidding operations, install water bars, particularly on skid trails on sloping and variable topography. If natural vegetation does not quickly establish on these trails, apply grass seed and cover with mulch (see Appendix E).



Figure 21. Example of Ephemeral Draw



12. WETLAND BMPS AND FOREST ROADS

A wetland is characterized by the presence of water at a frequency and duration sufficient to support, and that under normal circumstances does support, wetland vegetation, or aquatic life. These features are commonly referred to as bogs, swamps, or marshes. As mentioned above in the section on applicable regulations, the following activities are prohibited in wetlands, to protect water quality, unless a Part 303 permit has been obtained from the DEQ:

- Deposit or permit the placing of fill material in a wetland.
- Dredge, remove, or permit the removal of soil or minerals from a wetland.
- Construct, operate, or maintain any use or development from a wetland.
- Drain surface water from a wetland.

Regulated wetlands are defined in Part 303 and associated administrative rules.

Forest Road Construction in Forested Wetlands

Per Part 303, Wetlands Protection, of the Natural Resources and Environmental Protection Act, 1994 PA 451, as amended (NREPA), the activity of constructing forest roads or temporary roads for moving forestry equipment in a wetland environment is exempt from obtaining a Part 303 permit, as long as adverse effects on the wetland are minimized and best management practices as listed below are implemented. This guidance is for forestry purposes only. If roads are constructed in or through a forested wetland environment for non-forestry purposes or if fill material is deposited in a wetland, then a wetlands permit is required.

The following are general road construction BMPs, that, if applied, will minimize adverse effects on the wetland and allow the landowner, forester or logger to be exempt from obtaining a wetlands permit:

- Equipment access to wetlands should be minimized by utilizing knucklebooms or cranes or methods such as logging by cables from the adjacent upland where and when possible.
- If the crossing can be accomplished at a time when the wetland is relatively dry, construction mats or other temporary crossing methods should be employed. Following the operation, the wetland should be returned to its original condition.
- Conduct timbering operations during winter when the wetland is often frozen and passable and will not require the use of fill or other methods that may permanently damage the wetland.
- If there is an existing roadway through a wetland, that roadway should be utilized, unless upgrading to minimal standards will cause more wetland damage than selecting an alternative route.
- Wetland crossings should be held to the minimum feasible number, width, and total length consistent with the needs only of the forestry operations.
- Wetland crossings should be designed, constructed and maintained in a manner that keeps vegetative disturbance in the wetland to a minimum and prevents the disruption of migration or other movement of fish or wildlife within the wetland or contiguous water.
- Where fill is necessary, it should be taken from uplands and should consist of clean material. Upon placement, it should be stabilized and maintained to prevent erosion into waters or wetlands during and following construction. Depositing fill into a wetland requires a permit.
- Wetland crossings should include placement of culverts and other structures necessary to ensure adequate passage of flow under and through the road without causing excess drainage to upstream or downstream wetland areas. Drainage should be designed to maintain pre-existing hydrology on either side of the road.
- Wetland crossings may not be located in proximity to public water supply intakes or otherwise constructed at a location or in a manner where they would pose a threat to health, safety or welfare, or otherwise be in violation of federal, state or local laws.

- Always monitor operating conditions closely, but especially after the occurrence of a warm rain or above freezing temperatures at night. Cease operations in wetlands if ruts reach 6 inches in depth and are 25 feet long.

BMP Specifications for Forest Road Construction on Organic Wetland Soils

The federal publication, "Forested Wetlands: Functions, Use and Best Management Practices", (Forest Service publication number NA-PR-01-95), recommends different road construction techniques and BMPs, depending on the nature of the wetland soils in which forest management activity is scheduled to occur. One key component is that roads built on organic wetlands should provide for cross drainage of water on the surface and in the top 12 inches of the soil.

Construction techniques vary, depending on the type of soil involved (mineral versus organic). Where organic soils are involved, the depth of the organic layer also influences these techniques. The following practices, which differ based on soil type and thickness, are recommended for wetland road construction:

- For road construction on soils with **organic layers close to 16 inches** in thickness, these are the recommended practices:
 - Place 24 inch diameter culverts with their bottom half in the upper 12 inches of the soil to handle subsurface flows and the top 12 inches to handle above ground flows every 300 feet or so (see Figure 22).
- For road construction on soils with organic **layers in excess of 4 feet** in thickness, these are the recommended practices:
 - The road should be constructed across the top of the soil surface by placing fill material on top of geotextile fabric, while allowing for cross drainage via the use of a 12 inch thick layer of porous material such as large stone into the roadbed (see Figure 23). This material should be separated from the adjacent fill layers by geotextile fabric, and be incorporated into the road fill design so as to lie in the top 12 inches of the soil to provide continuous cross drainage. Corduroy or pvc bundles could be alternatives.
 - Where such porous layers are not used, place culverts at points where they will receive the greatest support from the soil below.
 - Construct ditches parallel to the roadbed on both sides to collect surface and subsurface water, so as to carry said water through a given culvert. Note that these ditches should be located 3 times the depth of the organic layers from the edge of the road fill.

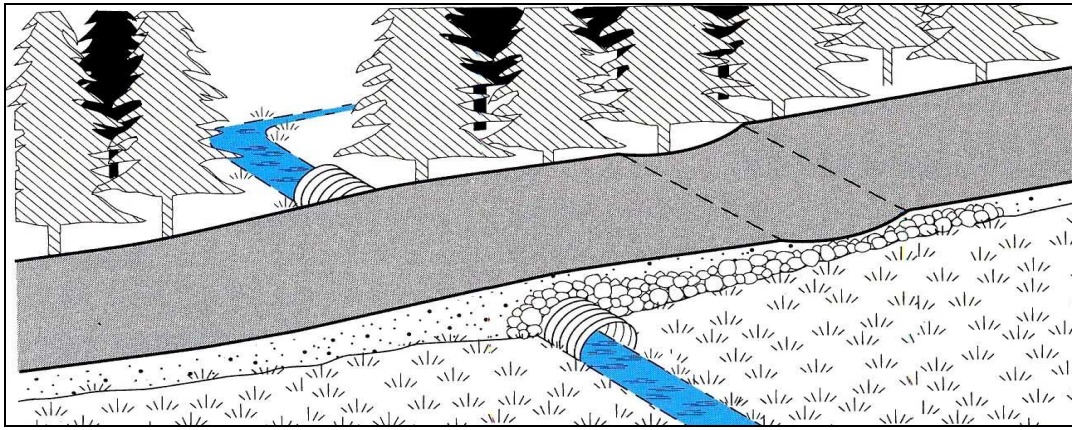


Figure 22. Proper Culvert Installation and Use on a Wetland Road.

(Re-printed courtesy of the United States Forest Service)

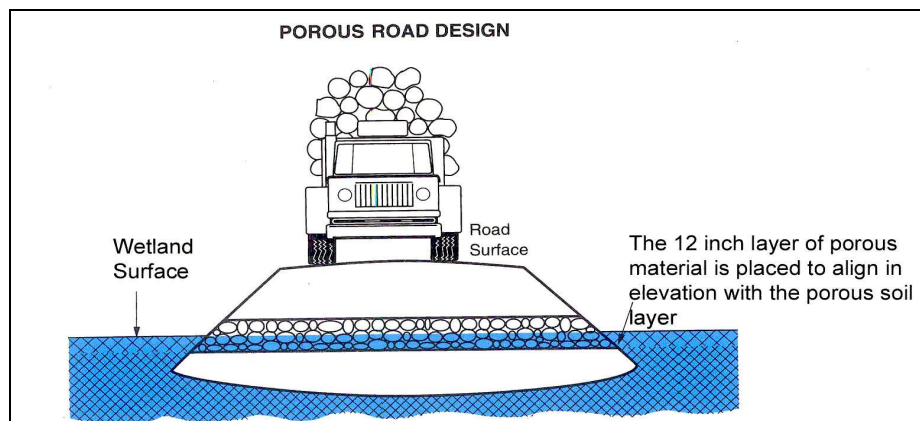


Figure 23. Porous Road Design Using Large Stone.

(Re-printed courtesy of the United States Forest Service)

- For road construction on soils with **organic layers between 16 inches and 4 feet** in thickness, these are the recommended practices:
 - Place fill directly on the peat surface and allow the fill to compress or displace the peat until equilibrium is reached. In this technique, culverts are used instead of porous layers to move flows through road fill material.
 - Place all culverts at the lowest elevation on the road centerline with additional culverts installed as needed to provide adequate cross drainage.
 - Construct all ditches parallel to the road centerline and along the toe of the fill to collect surface and subsurface water flows, carrying said flows through the culvert(s), redistributing the flows to the other side of the road.

Specifications for Roads Constructed on Mineral Soils or a Thin Organic Layer

When roads are being constructed on mineral soils or on soils with surface organic layers less than 16 inches in thickness, the following are the recommended practices:

- Roads through mineral soil wetlands can be constructed using normal road construction techniques.

- Apply geotextile fabric first before adding fill to increase bearing strength of the road and to preserve the bearing strength of fill material so as to prevent mixture with fine soil particles.
- In mineral soil wetlands, a culvert should be placed at the lowest elevation on the road centerline with additional culverts as needed to provide adequate cross drainage (see Figure 22 and 24).
- Shallow ditches parallel to the road centerline should be constructed along the toe of the fill to collect surface and subsurface water flows, carrying flows through the culvert(s) to the other side of the road and into a vegetated area (see Figure 24). Any ditches must be of depth and width only to allow cross drainage and support the stability of the road. **Deeper or excessive ditching will require a permit from the DEQ.**

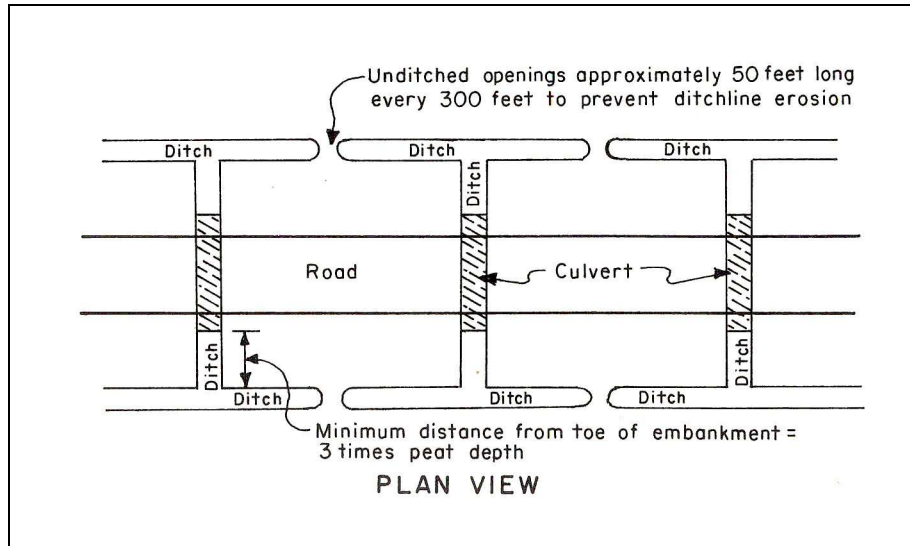


Figure 24. Illustration of Use and Placement of Culverts and Ditches for Wetland Roads.

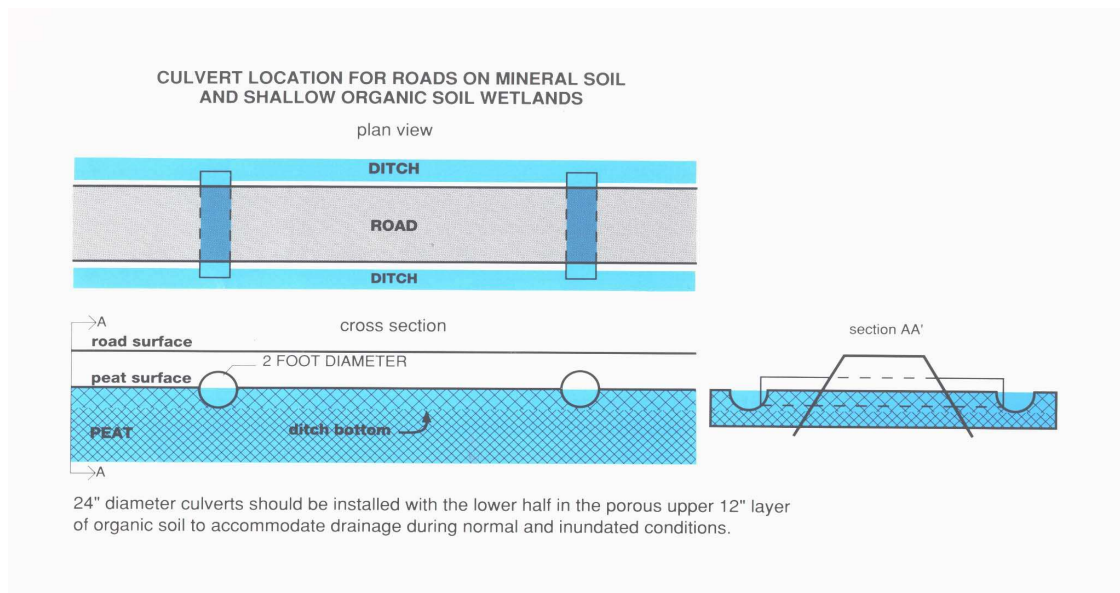


Figure 25. Cross-section of Culvert Location for Wetland Road.

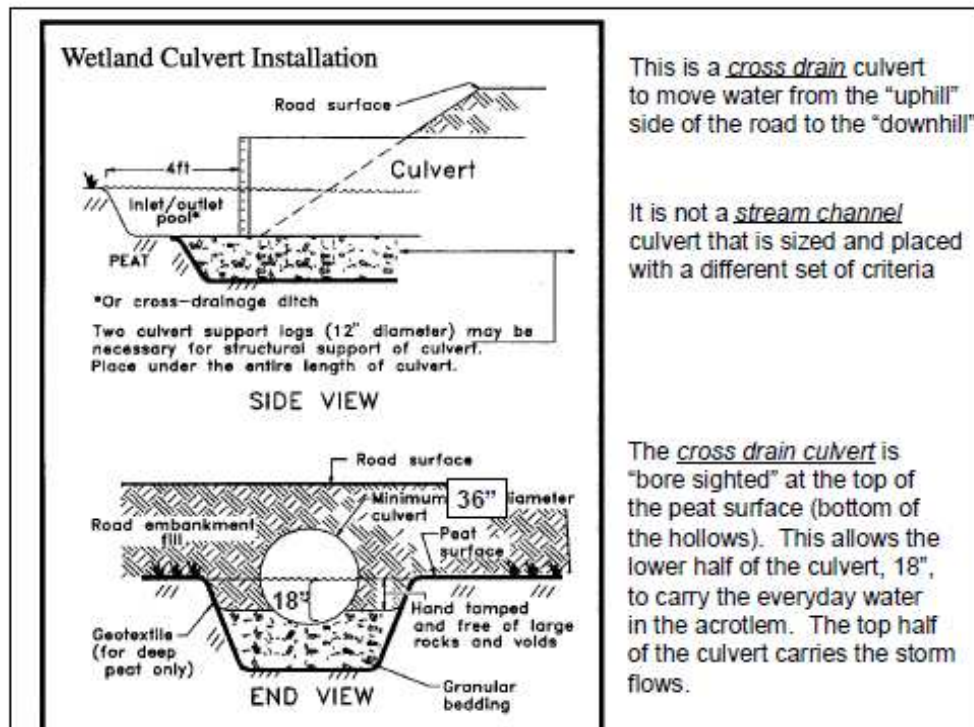


Figure 26. An Example of a 36-inch Diameter Cross Drain Culvert Used for a Road Constructed in a Wetland Area.

13. FOREST ROADS - CONTROLLING SEDIMENT MOVEMENT AND TRANSPORT DURING RAIN EVENTS

During rain events, excessive water flows can erode a forest road, causing sediment to be eventually transported into a stream or other water body. Described below are various devices that can help mitigate erosion and sediment movement. These devices work by interrupting the flow of water and sediment, causing the sediment to be deposited, trapped or filtered out before reaching an open water body. Following a routine maintenance schedule which takes into account rain events is key to the proper functioning of these devices. Generally, this is the responsibility of the logger during an active timber sale and the landowner's responsibility before and after such sales.

Described below are examples of such control devices:

- **Erosion Barriers** – Pre-seeded erosion control products at the toe slope of a road and at the outlets of culverts, diversion ditches, water bars, or broad-based dips, or the use of rock or large stone (an average diameter of 6 inches) placed on the toe of road and outlet of the diversion structures should be the first choices. Although it's cheap and handy, laying down slash is not very good in reducing the velocity and erosive impacts of concentrated flows during significant rainfall events.
- **Silt Fence** – A geotextile fabric, when installed properly, has the capability of retaining most suspended materials, (e.g. sediment) and releasing the filtered runoff through the fabric. Do not use in permanent flowing streams or in any location with concentrated flows. See Figure 5 for an illustration of how to properly install a silt fence. It is most commonly installed at or beyond the toe of a slope to trap sediment coming from overland sheet flows during a storm event. Silt fence must be installed along the same elevation contours across the slope to prevent runoff from flowing around the fence. For